Appendix A
2019 Bathymetric Survey Results

1 Introduction

Northwest Hydro, Inc. collected bathymetry data within the Lower Duwamish Waterway (LDW) upper reach in 2019 in accordance with the *Quality Assurance Project Plan: Pre-Design Surveys of the Lower Duwamish Waterway Upper Reach* (Anchor and Windward 2019), referred to herein as the Survey QAPP. The 2019 bathymetric survey was performed to meet the following three data quality objectives (DQOs) described in Table 1 in the Survey QAPP:

- DQO 1: Inform recovery category designation modifications.
- DQO 2: Inform selection of sampling locations.
- DQO 3: Provide a base map for the remedial design.

The bathymetric survey was conducted in April and May 2019 (Figure A-1). There were no deviations from the Survey QAPP, with the exception of limited data gaps in coverage that will be surveyed during the Phase I Pre-Design Investigation (PDI) as discussed below. The bathymetric survey also met all key targets and related data requirements, as listed in Table A-1.

Table A-1
Key Targets and Related Datums

Description	Quantity or Datum
Horizontal positioning accuracy	1.6 feet minimum
Horizontal survey accuracy	3 feet at a 95% confidence interval
Horizontal datum	NAD83/91 Washington North Zone
Vertical survey accuracy	+/- 0.5 feet at a 95% confidence interval
Vertical datum	MLLW

Notes:
Source: Table 3 of the Survey QAPP (Anchor and Windward 2019)
MLLW: mean lower low weight
NAD83/91: North American Datum of 1983/1991
QAPP: quality assurance project plan

As reported to the US Environmental Protection Agency (EPA) in May 2019, there are limited gaps in the bathymetric survey coverage, as shown in Figure A-1. These missing areas will be surveyed during the Phase I PDI in order to have full bathymetric survey coverage to develop the base map for remedial design.

The results of the 2019 bathymetric survey are sufficient to meet DQO 1, and they were used to develop a sun-illumination map to inform recovery category designation modifications. The recovery category designation evaluation is described in PDI QAPP Appendix B.

The results of the 2019 bathymetric survey are sufficient to meet DQO 2, and they were used to update maps in the main body of the PDI QAPP, superseding the 2003 site-wide bathymetric survey, in order to inform selection of sampling locations and application of remedial action levels (RALs).

As noted, the 2019 bathymetric survey will require supplemental bathymetric survey coverage in data gap areas to meet DQO 3.

This appendix presents notable features of the 2019 bathymetric survey that address DQO 2, focusing on elevations that determine which RALs are applicable per the Record of Decision (ROD) (EPA 2014). In particular, this appendix discusses shoaled areas of the federal navigation channel (FNC) that are shallower than the authorized navigation depth of -15 feet mean lower low water (MLLW); areas considered intertidal (shallower than or equal to -4 feet MLLW) and subtidal (deeper than -4 feet MLLW); and areas in the elevation range denoting "potential vessel scour" between -4 and -18 feet MLLW. The updated information for these areas will inform the locations and depths of PDI samples and the application of RALs, consistent with the ROD.

The 2019 bathymetric elevations indicate an overall shallowing of the bed elevations within the upper reach, consistent with the conceptual site model of the LDW. Certain areas indicate deepening since 2003, primarily due to navigation dredging, early action area remediation, and South Park Bridge demolition and reconstruction, all of which have changed localized hydrodynamics. The survey coverage within the upper reach is more comprehensive than the 2003 bathymetric survey. The 2019 survey extended farther upstream (to river mile [RM] 5.25) than the 2003 survey (which extended to RM 4.8) and provided more coverage in the shallow subtidal and intertidal areas adjacent to banks.

2 Shoaled Areas of Federal Navigation Channel

Areas of the FNC that are shallower than the authorized navigation depth of -15 feet MLLW are shown in dark green in Figure A-2. From RM 3.0 to RM 4.26, the shoaled area within the FNC has increased since 2003 due to net sediment deposition. From RM 4.26 to RM 4.7, the shoaled area of the FNC has decreased since the 2003 survey due to navigation dredging.

3 Areas Considered Intertidal or Subtidal

In the ROD remedy, an elevation shallower than or equal to -4 feet MLLW is defined as intertidal. Such areas generally did not change from 2003 through 2019 within the upper reach, with the intertidal mudflat areas remaining stable (Figure A-3).

Two notable exceptions are two marinas within the upper reach: South Park Marina at RM 3.38 to RM 3.5 west (W), and Duwamish Yacht Club at RM 4.04 to RM 4.16 W. These two areas were historically dredged to create water depth for marina use (i.e., subtidal). These two marinas

experience higher net deposition, likely due to the waterway widening at those locations and the marinas' deeper waters (relative to adjacent upstream and downstream water depths). Since 2003, both marinas have had significant net deposition that has raised the elevations in large portions to be shallower than -4 feet MLLW. However, for the purpose of implementing the ROD remedy, these areas are not considered to be intertidal, because they will require maintenance dredging in the future to restore the permitted marina operational elevations (subtidal) consistent with each marina's site use.

4 Potential Vessel Scour Areas

Potential vessel scour areas as defined by the ROD are between -4 and -18 feet MLLW south of the 1st Avenue South Bridge. As shown in Figure A-2, most of the subtidal area in the upper reach fell within this depth range in both the 2003 and 2019 surveys. However, the area deeper than -18 feet MLLW in the FNC was smaller in the 2019 survey than in the 2003 survey due to sediment net deposition in the navigation channel.

5 Bathymetric Survey Coverage Upstream of RM 4.8

The 2003 bathymetric survey did not collect elevation information upstream of RM 4.8 due to upper reach access restrictions caused by low bridge clearance. The 2019 bathymetric survey obtained elevation information all the way to RM 5.25. No comparisons between 2003 and 2019 data were possible upstream of RM 4.8 due to a lack of 2003 elevation information.

6 References

Anchor, Windward. 2019. Quality assurance project plan: pre-design surveys of the Lower Duwamish Waterway upper reach. Final. Anchor QEA and Windward Environmental LLC, Seattle, WA.

EPA. 2014. Record of Decision, Lower Duwamish Waterway Superfund Site. Part 3. Responsiveness summary. US Environmental Protection Agency, Region 10, Seattle, WA.

Appendix A Figures